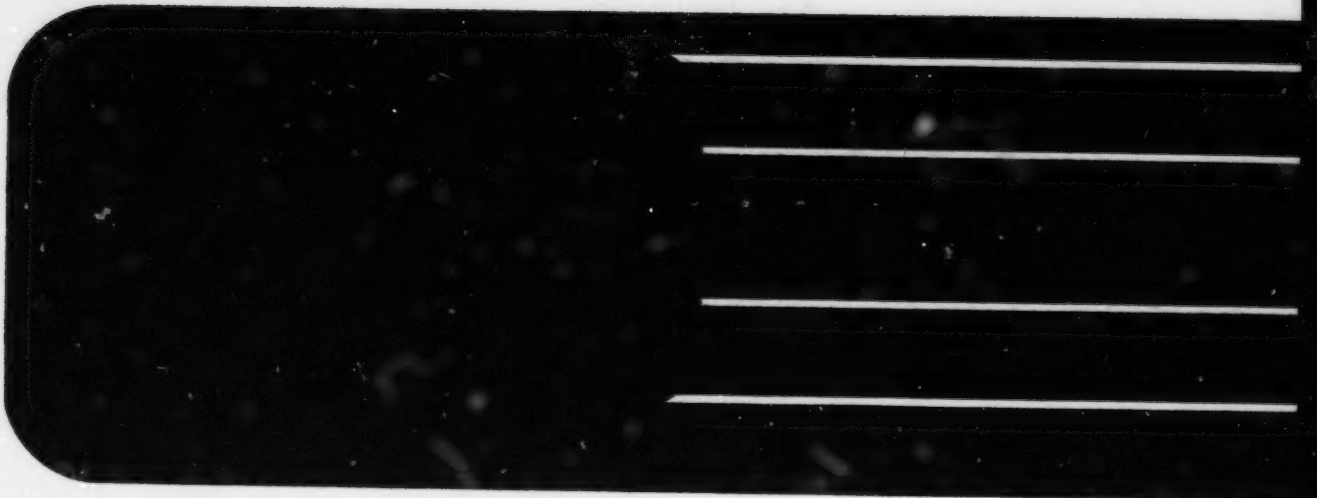




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**MANITOBA HAZARDOUS WASTE
MANAGEMENT CORPORATION
TRANSPORTATION RISK ASSESSMENT
PART 1 - DATA COLLECTION
AND MODEL DEVELOPMENT**

**M. M. DILLON LIMITED
CONSULTING ENGINEERS
AND PLANNERS**

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DILLON
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1.0

INTRODUCTION

As the efforts of The Manitoba Hazardous Waste Management Corporation (MHWMC) continue in the areas of site and technology selection, it has identified the need to address the transportation risk associated with movement of waste. This relates to the transport of hazardous wastes within an overall hazardous waste management system being developed in the province and specifically to movements from the generator to the various offsite facilities required. The examination of this issue is being undertaken for several reasons. Functionally, the principal is to assess the economic implications and actual risks associated with the development options such that these can be given optimum consideration in the final design of the system. However, in doing so it is also hoped the work can address a major public concern that perceives transportation as a major risk, in relation to that which exists in its absence.

As the first stage of this work, M. M. Dillon Limited have been retained by the Corporation to develop a detailed data base and transportation model with which quantified transportation risk assessment can be made for various system scenarios.

The transportation network being considered included all Provincial Trunk Highways (P.T.H.'s) and the main rail line subdivisions. Work began in early summer of 1989 gathering traffic volume and accident data from road and rail sources for the chosen transportation network. The task of efficiently modelling this information, the physical network and associated traffic/accident data, is best suited to computer application of transportation planning/analysis packages.

The package selected for this project is called MOTORS. MOTORS was developed by M. M. Dillon Limited for transportation projects and is a versatile

tool for system planning and analysis, both existing and proposed. This program has been widely used for projects across Canada, including the following which have similar characteristics to the work being undertaken here.

- Ontario Waste Management Corporation: The MOTORS program was used to provide transportation input to the OWMC Environmental Assessment and included model analysis of vehicle routing, transportation costs, accident involvement and spill risk forecasts for various facility operation combinations.
- Winnipeg Municipal Solid Waste Transfer Station: The MOTORS computer program and extensive spreadsheet analysis were used to assist in the site selection of the Winnipeg Municipal Solid Waste Transfer Station. The program took into account the routing network, travel times along all links of the system, waste distribution rates for various areas of the city, and vehicle operation costs.

More specific reasons for selecting MOTORS include the programs capability of illustrating traffic volumes, dangerous goods movements and accident probability along a finite number of links in the network. Superimposed on this transportation network can then be the hazardous waste production network. The product is a model that can estimate the total hazardous waste traffic generated for any given system scenario. It can also demonstrate this traffic's impact on the existing dangerous goods movements within the province in relative terms. In terms of risk, the model is able to determine accumulated accident probability involving hazardous waste carriers based on the current performance of the transportation system. This output is used to perform the transportation risk assessment for the given system scenario.

It should be noted that the model is only as good as the data provided to it. In this project, every attempt to acquire the needed data was focused on the

best available information to date. Data on general road and rail traffic is gathered regularly and has good historical background. Data collection in the transport of dangerous goods is a relatively recent practice. Therefore, its foundation is not as healthy as the general traffic records. However, the format of this work and subsequent phases will allow for updating the data base as more recent and better information becomes available.

This is a brief introduction to what is better explained in the following pages. The report is divided into three sections that layout the work done to date in preparing for the actual transportation risk assessment of the system(s) proposed by the Corporation. These sections are as follows:

- Transportation Overview and Study Scope
- Data Retrieval
- Transportation Risk Assessment Methodology

A concluding discussion is made that basically summarizes the status of the work and the requirements for proceeding with the complete transportation risk assessment on an option specific basis.

2.0

TRANSPORTATION OVERVIEW AND STUDY SCOPE

The movement of hazardous waste in a waste management system involves two basic functions; handling and transportation. Hazardous waste is collected by the generator at source and prepared for transport to a final disposal location in accordance with the requirements of the Transportation of Dangerous Goods Act. Typically these wastes are packaged either as liquid wastes or as non-liquid (non-pumpable) waste requiring tank transport or drummed transport, respectively. Therefore, the typical vehicles used to collect hazardous wastes are tanker trucks or van trucks. The size of vehicle relates to the volume of waste produced by the generator.

After collection, the hazardous waste may be shipped directly to the central treatment/disposal facility. However, in some cases, it may be more economical to institute a system of transfer stations where small quantities collected from smaller generators can be bulked or combined with other compatible wastes. When a sufficient quantity of waste has been gathered, it can be more efficiently shipped to the final treatment/disposal facility. The effect of the transfer stations is to optimize transport costs and limit the number of hazardous waste movements for longer distance pick-up/deliveries.

The transportation network is made up of the generator (production) nodes and destination nodes (final treatment/disposal or transfer station). These nodes are connected by links in the provincial, road and rail infrastructure. For the purpose of this study, only the main highway links (P.T.H.'s) and main rail lines were considered. It was felt that most industrial development generally responsible for the production of hazardous waste would be situated with relatively close proximity to these highways and rail systems and definable nodes within them. Therefore, further breakdown of the transport network to highway collectors was deemed unnecessary at this point. However, this would not preclude some model modification for a specific

operation as it is identified. Such a modification would include the collection systems within an urban area servicing a major transfer station operation located in close proximity to it.

The scope of this study is to develop a model of the provincial transportation network that would identify the P.T.H. network, the main rail line network and the generator (production) network. The destination network relies on successful siting of the final treatment/disposal facility, transfer station and export options. In addition to model development, a detailed data base of traffic volumes, existing dangerous goods movements, expected hazardous waste shipments, general accident rates, and (hazardous/dangerous) accident histories is to be included in the model. Finally, a method of transportation risk assessment is to be developed that can evaluate the data and produce a quantified appreciation for the risk associated with the proposed transportation system, both in absolute terms and in comparison to current risk associated with comparable dangerous goods traffic.

It should be noted that the scope does not include any specific system evaluation. Only the tools have been prepared to a level where they are ready for specific system input. The details of the hazardous waste management system are still to be confirmed; i.e. treatment disposal site, transfer station sites, import, export, etc.

3.0 NETWORK MODEL DEVELOPMENT

The previous section identified that the model is made up of generator (production) nodes, destination nodes (final treatment/disposal and/or transfer stations) and the road and rail infrastructure. The road network has been split up into links matching the format of The Manitoba Highways and Transportation Department accident record keeping. The rail network is based on subdivision lines. The generator nodes are cities and towns in the province with known (or expected) quantities of hazardous waste production. This network model is illustrated on Drawing TRA-1. The remainder of this section covers the data retrieved for the network model and the proposed MOTORS model analysis.

3.1 Data Retrieval

3.1.1 Road Network

The bulk of data gathered on the road network is from The Manitoba Highways and Transportation Department. Some input was also obtained from The Manitoba Trucking Association and other general transport services.

Volumes

Traffic volumes along the P.T.H. network for the year 1987 were used for this study. This is the latest year where complete data is available, and as such is the most indicative of the present situation. Information supplied by the Manitoba Department of Highways and Transportation states that the annual growth rate for the P.T.H. network averages 2.5%, with rates ranging from 1.0% to 4.5%. The higher growth rates are experienced on highways connecting economic centers (i.e. east/west for into and out of province trips and north/south for travel to and from the U.S.).

Drawing TRA-2 illustrates the road network and lists the traffic volumes along those links in three different traffic categories:

- total traffic
- commercial truck traffic
- dangerous goods truck traffic

Dangerous Goods Volumes

Traffic volume data is actually only available for the total traffic stream and commercial truck traffic stream. The dangerous goods movements indicated are estimates based on periodic roadside surveys. Roadside surveys in the U.S. have suggested 10 to 13 percent of the commercial traffic stream involve dangerous goods movements. The Manitoba Trucking Association supports a 10 to 15 percent estimate for the component of dangerous goods carriers within the commercial traffic stream. Observations made by the Hazardous and Special Wastes section of the Environmental Management Services Division of The Department of Environment and Workplace Safety and Health indicated that 11 percent of the trucking traffic was carrying dangerous goods.

As part of this study, an attempt was made to assess the dangerous goods content distribution by conducting a field survey at weigh scale stations in the province.

The field verification took place July 5 - 7 (Wednesday - Friday) during the hours 9:00 A.M. to 5:00 P.M. Interviews with the traffic inspectors suggested that there is a great deal of hazardous/dangerous goods movement in the off-hours (before 8:00 A.M. and at night) because of improved traffic conditions. The traffic inspectors supported the claim that the daily average could be closely approximated by the 10 to 15 percent assumption.

Of the vehicles recorded in the field verification survey, 75 percent carried fuels, 10 percent carried liquified gases, 10 percent carried poisonous, corrosive substances and 5 percent carried miscellaneous dangerous goods. It should be noted that while the data applies to placarded vehicles, some of which may carry partial or mixed loads of regulated and non-regulated materials, this would only be applicable to a small percentage of the dangerous goods movements. In addition, a significant amount of dangerous goods movements are very local in nature and therefore would escape being identified in any provincial traffic survey.

For the purpose of this study, the component of dangerous goods in the road network was estimated using 10 percent of the commercial traffic stream. This should provide a conservative comparative analysis for incremental hazardous waste movements, recognizing that the overall proportion of dangerous goods movements may well be greater than assumed.

Field verification of the actual amount of dangerous goods traffic can be conducted on specific routes as part of the risk assessment.

Accident Data

For the purpose of predicting transportation risk associated with the transport of hazardous waste, general accident data for the roadway network is required. It is also desirable to have some understanding of the ratio of accident frequency for trucks compared to the general accident frequency and the number of spills per truck accident involving dangerous goods.

The Manitoba Highways and Transportation Department keeps accident data by control section along the entire provincial roadway network. As mentioned previously, the roadway link system was set up to match the control sections

of the departments accident record keeping. Drawing TRA-3 illustrates the roadway network with the general accident frequencies experienced for the year 1987. Data from years 1984 to 1988 was obtained for study back-up. Analysis of the accident data for these years revealed an annual accident growth rate of 2%. This correlates with the volume growth rate of 2.5%.

Data is available on specific vehicle types involved in making up the general accident frequencies. However, it must be researched by hand (as opposed to computer search) and this is an extremely time consuming task if proposed for the entire P.T.H. network. It was decided early on in the study that for the initial transportation risk assessments, the ratio of truck accident frequency to general accident frequency would be the same as the respective traffic volume ratios. When more specific routing of the hazardous waste transport system is known, this assumption can be reviewed with a more detailed data search.

Some specific data for western Manitoba was reviewed for the May 1988 to June 1989 period. It showed six transportation accidents occurred west of Portage and south of Dauphin, two of which occurred on P.T.H. #1 (Trans-Canada Highway) and two on P.T.H. #16 (Yellowhead Highway). The quantity of material released ranged from 4 litres to 5400 litres, and involved fuel, pesticides, and fertilizers.

The number of dangerous commodity spills for truck accident can also be approximated using Manitoba Dangerous Good Accident Reports and general accident history information. In 1987, there were 206 transporters of dangerous goods involved in traffic accidents in Manitoba (source: Statistics Canada, 1987). In 1988/1989, of 405 there were 69 transport related accidents reported from all of Manitoba that resulted in a spill of a dangerous commodity. Of these accidents, greater than 50 percent occurred in Winnipeg. Of the remaining, roughly 25 percent occurred on the P.T.H. network. This

assumption is based on annual accident data by "place of occurrence". Therefore, the number of dangerous commodity spills along the P.T.H. network outside of Winnipeg in 1988/1989 is approximately 15 to 20.

From the above observations, the following can be identified:

- general accident frequency - listed for each link on Drawing TRA-3 (based on 1987 data)
- ratio of truck accident frequency to general accident frequency - link specific extracted from Drawing TRA-2 "Road Traffic Volumes" (approximately 15 percent)
- ratio of dangerous commodity spills to truck accident frequency - 3 percent (This number appears to be low. However, one should recall that only 10 percent of the commercial truck traffic is assumed to carry dangerous commodities. Therefore, it can be shown that there is approximately a 1 in 3 chance that a carrier of a dangerous commodity that is involved in an accident is also involved in a spill.)

3.1.2 Rail Network

Data on the rail network has been more difficult to obtain than roadway information. The basic reason for this experience is that there is no central agency that maintains complete records of the operations of the two main railways in Canada. Therefore, the sources are many and usefulness of source input varied. Some sources are C.N. Rail, C.P. Rail, CANAC Consultants Ltd., National Transportation Agency and Transport Canada.

Volumes

Volume data was obtained for C.N. Rail operations in 1988 from CANAC Consultants Ltd. This information is listed in Table 3-1 and presented in rail network fashion on Drawing TRA-4.

Volume data from C.P. Rail was accessible but not easily extracted from the operational statistics kept by this rail company. It was decided to forgo collection of rail volume data for the entire C.P. Rail provincial network because of the time required to complete this task. Instead, more specific rail line data could be requested and obtained once it could be determined which C.P. Rail subdivisions would be of interest. Therefore, this data collection work would be done in the subsequent phases of the overall Transportation Risk Assessment.

Dangerous Goods Volumes

The rail companies transport tremendous volumes of dangerous commodities on an annual basis. Information received from The Transport Dangerous Goods Directorate of Transport Canada relative to 1986 dangerous goods movement within Manitoba is shown on Table 3-2. The total quantity of dangerous goods shipped on Manitoba rail lines in 1986 was in excess of 3.3 million tonnes. The primary routing of these goods is along rail lines that exit/enter the province.

The total quantity described above is shared approximately 50/50 by the two major rail companies. This observation is based on preliminary information obtained from CN relating to dangerous goods hauled through the province. They also qualified that the primary routing of dangerous goods in Manitoba is CN mainline trackage (Malachi, Ontario to Winnipeg to Brandon to Melville, Saskatchewan).

TABLE 3-1
CNR RAIL NETWORK AND TRAFFIC VOLUME
1988 TOTAL TRAFFIC

No.	CN Subdivisions	Traffic		
		Trains	Loads	Tons (000)
1	Carberry	368	14,150	849
2	Carman	86	1,510	87
3	Chisel Lake			
4	Cowan	237	4,889	308
5	Cromer	358	11,263	674
6	Erwood	128	3,511	182
7	Flin Flon	614	9,189	494
8	Gladstone	1,980	83,030	5,563
9	Hartney	119	1,602	86
10	Herchmer	147	1,823	113
11	Inwood			
12	Letellier	732	16,156	1,034
13	Miami	169	3,239	191
14	Neepawa	295	2,344	150
15	Oak Point	177	4,051	243
16	Pine Falls	250	6,064	376
17	Preeceville	221	4,078	261
18	Redditt	3,807	152,824	8,711
19	Rivers	7,678	255,250	16,336
20	Rosburn	195	1,651	104
21	Sherridon	316	2,063	130
22	Sprague	3,511	216,954	14,102
23	Steep Rock	168	3,619	228
24	Thicket	341	5,738	350
25	Thompson	208	2,317	139
26	Togo	1,817	79,231	5,150
27	Turnberry	429	14,344	918
28	Wekusko	947	5,806	360
29	Winnipegosis	132	3,969	169

TABLE 3-2
1986 DANGEROUS GOODS MOVEMENT BY RAIL
WITHIN MANITOBA

MOVEMENT	CARS	TONNES	TONNES/CAR
Originating within Manitoba and terminating within Manitoba	2,381	147,920	62.1
Originating within Manitoba with destination outside of province	7,656	436,920	57.1
Originating outside of province with destination inside Manitoba	16,644	869,484	52.2
Originating east of Manitoba and terminating west of the province	23,940	706,483	75.7
Originating west of Manitoba and terminating east of the province	15,104	1,143,940	29.5
TOTAL	65,725	3,304,747	

Note: The low quantity per car originating east of Manitoba and terminating west of Manitoba possibly contains a large number of empty back haul containers that hold residual amounts of dangerous goods.

Note: 1986 was the most recent data available. 1988 data has been requested and should be available for Part 2 of this study.

From the data supplied by C.N. Rail (i.e. total rail traffic volumes and total dangerous goods traffic volumes, 1988) it can be shown that approximately 6 percent of all C.N. Rail traffic involves dangerous goods. This is quite likely the case with C.P. Rail traffic as well. This will be confirmed with actual C.P. Rail traffic data prior to actual Transportation Risk Assessment along any chosen rail routes.

Accident Data

In comparison to roadway statistics, there are fewer railway accidents per unit of rail traffic. In 1988, there was a total of 54 incidents involving dangerous goods. Based on the best available information to date, this translates to roughly an 0.08 percent spill to dangerous goods load ratio. This figure will be confirmed, prior to undertaking any actual risk assessment, with the expected 1988 volume data. The incidents quoted above can be further broken down into categories of severity (Transport Canada, 1988):

A.	minor leak in rail car	45%
B.	minor leak in container (drum)	25%
C.	mechanical problems	15%
D.	minor derailment/accident	15%

Drawing TRA-5 pinpoints these accidents by category.

3.1.3 Hazardous Waste Quantities and Origins

Hazardous waste generators are required to be registered as such with the province of Manitoba. Movements of hazardous wastes are tracked using a manifest system (shipping document for hazardous waste). The system monitors hazardous wastes within Manitoba, out of Manitoba and into

Manitoba. However, the system does not monitor shipments that merely pass through Manitoba.

The following table shows the total quantity (in kilograms) of each class of hazardous waste shipped in Manitoba during 1988 based on manifest information (Environmental Management, 1988):

<u>Class</u>	<u>Quantity (kg)</u>
2	237
3	638,782
4	49,869
5	68
6	268,213
8	1,323,368
9	<u>590,525</u>
TOTAL	2,871,062

Class 1 (explosives) and Class 7 (radioactive materials) are excluded from the above table as they are not shipped as waste under The Transportation of Dangerous Goods Regulations. These materials are controlled by other federal legislation. The total quantity for Class 8 wastes in the above table is considerably higher than the total quantities for the other classes as it includes several shipments of waste automotive batteries (containing acid) shipped out of Manitoba for recycling.

With the development of the Manitoba Hazardous Waste Management Corporation's (MHWMC) system and increasing regulation, a significant increase in hazardous waste shipments can be expected. This is due to the fact that many of the existing generators are stockpiling waste on site, sewerage liquid wastes, or disposing of them otherwise. Once the opportunity for proper management is available, most of those wastes will be capturable by the system.

The MHWMC provided the data base on hazardous waste production based on its Hazardous Waste Market Characterization Study for Manitoba, (MHWMC, 1989). The breakdown of hazardous waste production by location was extensive. Therefore, it was deemed appropriate to regionalize some of the locations. Where some smaller towns were lumped together, it was assumed that the production location would be at the town furthest away from Winnipeg. This would tend to slightly overestimate the length of P.T.H. network or rail line network affected by hazardous waste transport. A summary of the regionalization is shown in Appendix A.

Table 3-3 lists out the regionalized production nodes and their contributing quantities. This table represents the estimated total capturable amount to the provincial hazardous waste management system that would include:

- a treatment/disposal facility
 - any local Resource Recovery efforts*
 - any export to outside treatment/Resource Recovery* facilities
-
- *via a transfer station facility*

The MHWMC has put together estimates by quantity and class of what they expect to receive in their system and at their central facility. This data is presented in Table 3-4. The difference in total quantities between the "Projected Quantity" and "Facility Quantity" in Table 3-4 represent those quantities expected to be recycled or managed elsewhere, in or out of Manitoba. These quantities would likely be routed through a transfer station facility.

TABLE 3 - 3
REGIONALIZED PRODUCTION NODES
AND ANNUAL CONTRIBUTION
OF HAZARDOUS WASTE
TO PLANNED SYSTEM

NODAL NUMBER	NODAL REGION NAME	NODAL REGION CONTRIBUTION (KG/YEAR)
1	WINNIPEG	19,067,203
2	SELKIRK	1,323,255
3	BRANDON	408,076
4	THOMPSON	250,181
5	WINKLER	201,234
6	FLIN FLON	196,072
7	PORTAGE LA PRAIRIE	150,822
8	SNOW LAKE	88,933
9	STEINBACH	85,534
10	DAUPHIN	75,848
11	MORDEN	64,083
12	MORRIS	55,864
13	PINE FALLS	44,773
14	THE PAS	47,300
15	NEEPAWA	41,742
16	VIRDEN	38,905
17	ALTONA	38,729
18	SWAN RIVER	38,268
19	ST. PIERRE JOLYS	33,964
20	BEAUSEJOUR	27,454
21	GIMLI	24,506
22	LAC DU BONNET	24,152
23	CARMAN	23,498
24	ILE DES CHENES	19,570
25	ROBLIN	19,006
26	NIVERVILLE	18,201
27	TREHERNE	16,979
28	KILLARNEY	15,795
29	TEULON	14,765
30	CARBERRY	14,304
31	MANITOU	14,214
32	ST. CLAUDE	13,507
33	ROSSBURN	13,402
34	MINNEDOSA	13,135
35	ARBORG	12,298
36	RICHER	12,276
37	ST. LAZARE	11,846
38	STONEWALL	11,131
39	SOURIS	10,793
40	BOISSEVAIN	10,529
41	ASHERN	9,824
42	GRAND RAPIDS	8,808
43	DOMINION CITY	8,516
44	RIVERS	8,149
45	ERIKSDALE	8,100
46	MELITA	7,475
47	GLENBORO	7,444
48	CRYSTAL CITY	5,551
49	SPRAGUE	5,192
50	HAMIOTA	3,618
	TOTAL	22,667,634

TABLE 3-4
MARKET CHARACTERIZATION SUMMARY

CUCD	Waste Type	Characterization Quantity (tonnes/y)	Projected Quantity (tonnes/y)	Facility Quantity (tonnes/y)
1	Organic Sludges	212	299	299
2	Solvents	442	708	354
3	Oils & Greases	889	5,668	0
4	Oil/Water Mixtures	538	1,026	103
5	Organic Residuals	9	86	17
6	Inorganic Solutions	1,682	2,993	2,993
7	Misc. Chemicals	25	71	71
8	Paint Residuals	289	639	639
9	Aqueous Organics	338	666	666
10	Anion Complexes	1,690	6,163	6,163
11	Inorganic Sludges	3,504	4,043	2,295
12	Pesticide & Herbicide	2.3	12	75
13	PCB Waste	16	16	500
14	Clean-up Residuals	145	44	1,044
15	Pathological Waste	77	279	0
Totals		9,858	22,713	15,219

(MHWMC, 1989)

The previous section outlined the comprehensive data retrieval process designed to prepare a network model capable of assisting in transportation risk assessment. At face value, the data base illustrated on drawings TRA-1 to TRA-5 are useful in appreciating the order of magnitude of existing traffic, and existing dangerous goods movements, and accident frequency patterns. Another feature of the model development is the incorporation of the MOTORS network analysis computer program into this study.

MOTORS, developed by M. M. Dillon Limited for route optimization studies, is used to perform three functions:

- route optimization by shortest travel time or distance
- determine accumulated accident probabilities along selected routes
- route optimization by minimum accumulated accident probability

Data input to the program includes all the information described in the previous section. The program has the ability to review all the possible route selections from a production node to a destination node and choose the route of least time or least distance (depending on specified request). Therefore, once site options have been established for the various system facilities, all the hazardous waste deemed captured by it can be allocated a route in the road or rail network. A lot of the links in the system may not be affected. However, the links that converge on the facility, will receive the accumulated affect of all waste being delivered to the facility.

A similar process can be requested of the program where the general accident rate is specified as the governing factor. The accumulated accident probability for the least time or distance route can be determined. In addition, the sensitivity of the accumulated accident probability can be tested by modifying

the route selections. Ultimately, and if deemed necessary, the route of least accumulated accident probability can be determined.

Running of the program is dependent on having destination options. These can be many and can vary for a single production node to account for different destinations for different classes of hazardous wastes produced. For example, the final hazardous waste management system may include a treatment/disposal facility anywhere in Southern Manitoba away from Winnipeg, a transfer facility in or near Winnipeg, export of certain wastes to the U.S. and others to other provinces in Canada. Similarly, it could combine the treatment/disposal facility with the transfer station in or near Winnipeg. The MOTORS program can determine the routing (based on least time, least distance or least accident probability) to each of the destinations from all of the production nodes. In the cases where a particular waste class has destination options (i.e. it is not restricted to delivery to one particular destination) the program will identify the most appropriate destination.

The program may also be used to design the transport system respecting the implementation of regional transfer stations. A series of well sited small transfer stations may assist to minimize transport costs and transport related risk. However, this exercise is not within the scope of this study and can be left until subsequent phases of the hazardous waste management system are developed.

While not under consideration by the MHWMC, another possibility that can be added to the model is import of hazardous waste. Should it be desirable to examine the impact of waste imported to the province, a "dummy" production node, with its related waste stream characteristics, can be set up at its likely entry point into the province. As with the destination nodes, these features are yet to be confirmed.

A significant task in setting up the MOTORS modelling program involves model calibration. This activity involves formatted data entry to computer file of all data elements per network link. It then requires sample computer runs to make sure the output is reasonable and all data was entered correctly. This activity is complete and the MOTORS model is ready to be put to work.

4.0 TRANSPORTATION RISK ASSESSMENT METHODOLOGY

The transportation of waste from the source through to final treatment and disposal facilities can represent a greater risk or potential for impact than the facilities that have been properly sited and designed to accept these wastes. It is essential, therefore, to understand the potential risk and impact associated with the movement of waste along the selected transportation route.

To accomplish this evaluation, careful consideration must be given to the characteristics of the waste, the nature of potential receptors along the route, and a range of accident scenarios that could occur, such as spills, fires, personal injury accidents, etc. Traditionally, the evaluation involves the modelling of the various accident scenarios at critical locations along the route. The risk associated with the route is the probability of a particular event occurring and the consequence of this event over both the short and long term.

This section outlines the methodology for the next phase of work which involves specific system transportation risk assessment. The objective of the transportation risk assessment can be twofold. The first component will provide a quantitative assessment along access routes "before and after" system implementation. The second component is only applicable if more than one system is being evaluated. Its objective will be to produce output allowing a comparison that can rank the options in terms of transportation risk or become part of a larger systems comparative evaluation. The former may have more benefit in public consultation as the output can be viewed very location specific (i.e. by link).

The proposed methodology for the transportation risk assessment is as follows:

- (a) input destination nodes to model network and identify destination options for each waste class;
- (b) run MOTORS trip assignment program that will allocate the hazardous waste to the road or rail network;
- (c) plot, from MOTORS graphics, provincial road and rail network drawings with hazardous waste routing highlighted and quantities by link listed;
- (d) plot, from MOTORS graphics, provincial road and rail network drawings with hazardous waste routing highlighted and estimated accident frequency involving:
 - i) hazardous waste shipment vehicle
 - ii) hazardous waste shipment vehicle resulting in a spill

Notes: The two maps produced from (c) and (d) above will give the viewer a first look at the increase in dangerous goods movements along a specific link. It will also give the probability value of an accident (or spill accident) involving a hazardous waste carrier along a specific link relative to what it currently is.

- (e) conduct a desk-top reconnaissance of all routes identified with the objective of identifying the following route specific environmental and public safety issues:
 - i) number of water crossings
 - ii) number of at-grade rail/road crossings
 - iii) number of residents within close proximity to route

- iv) number of large residential groupings or recreational areas within close proximity to route
 - v) ground water pollution hazard areas
 - vi) communities that have Emergency Response Personnel (ERP) or Emergency Response (ER) capability
- (f) identify links from above survey that require field verification (these may be the links that converge on a particular destination). Conduct this field verification;
- (g) highlight the potential consequences of the predicted accidents along the specific routes associated with the environmental and safety issues. This will also be a function of the class of waste identified as being transported along that route;
- (h) address mitigation of the transportation risk through:
- i) rerouting to avoid sensitive environmental or public safety areas
 - ii) rerouting to avoid high accident risk areas

Notes: Divided highways have a significant lower accident rate compared to undivided highways. The average divided highway has an accident rate 25 percent less than the average undivided highway. Therefore, it could be advantageous to reroute from undivided roadways to divided roadways to reduce accident risk.

- iii) recommendation of roadway facility improvements to reduce link specific accident risk

Notes:

As was stated earlier in the report, detailed accident data by roadway link is available. If along any of the selected routes for hazardous waste, an unusually high accident rate is encountered, review of the specific file data could identify a common source for most of the accidents (i.e. poor intersection operation, typical poor drifting snow conditions, routing through a town, etc.) These items can be identified and it may be more appropriate to upgrade the selected routes at problem locations than to propose rerouting.

- iv) restricting transport of the more hazardous wastes by sensitive environmental and public safety areas along the selected routes
 - v) vehicle containment design focused on minimizing risk and consequences of accidents
 - vi) development of operating schedules (hours of operation) and other related operating restrictions.
- (i) produce a recommended plan for the routing of hazardous wastes within the system taking into account the mitigative measures suggested from the previous steps. The resultant plan would highlight the routings, list the quantities of waste by link and identify the probability of accidents involving a hazardous waste shipment (with and without a spill).

The second phase of the transportation risk assessment would be undertaken if more than one access scenario was being evaluated. Steps involved in this process are intended to produce indicators that can facilitate system comparisons.

This item was not identified in the original scope of work. It would be necessary to review the major differences between the systems under review and the results of the first part of the transportation risk assessment with the MHWMC to detail the methodology of this activity. However, it could involve a comparison framework similar to the following:

FACTOR/FACTOR INDICATOR	FACTOR INDICATOR VALUE
1. Transportation	
• route exposure	total length of network exposed (veh. km or tonnes km)
• accidents	total system accident probability (accidents/year and/or spills/year)
• traffic operations	number of operational problem areas along routes (icy, snow drifting, difficult intersections, etc.)
2. Environmental & Public Safety	
• number of watercrossings	total number
• number of at grade road/rail crossing	total number
• number of residences within a specific distance from the route	total number
• number of communities and/or recreational areas within a specified distance from the route	total number
• ground water pollution hazard areas	distance travelled through area

Public consultation to identify other factor/indicators to incorporate in the comparative analysis is also recommended.

In summary, the original scope of this study relates to the P.T.H. network and main rail line network. This section outlined the detailed methodology planned for the transportation risk assessments along this network.

5.0

CONCLUDING DISCUSSION

The status of the project at this time is that data retrieval process is complete with the exception of the total rail traffic volumes. The MOTORS model development is complete and is ready to input destination characteristics of the proposed hazardous waste management system. A methodology for detailed transportation risk assessment has been proposed and has not been applied on a system specific basis as yet.

The data presented in map form illustrates the magnitude of existing traffic and existing dangerous goods movements as well as the distribution of hazardous wastes across the province.

To proceed with the specific transport risk assessment the following items are required:

- review and approval of proposed methodology
- identification of destination nodes and waste class specific options
- additional discussion of rail vs. road in consideration of destination nodes identified

This draft report is respectfully submitted by M. M. Dillon Limited.

Respectfully submitted,

M. M. DILLON LIMITED

S.M. Pellerin, P. Eng.
Project Manager

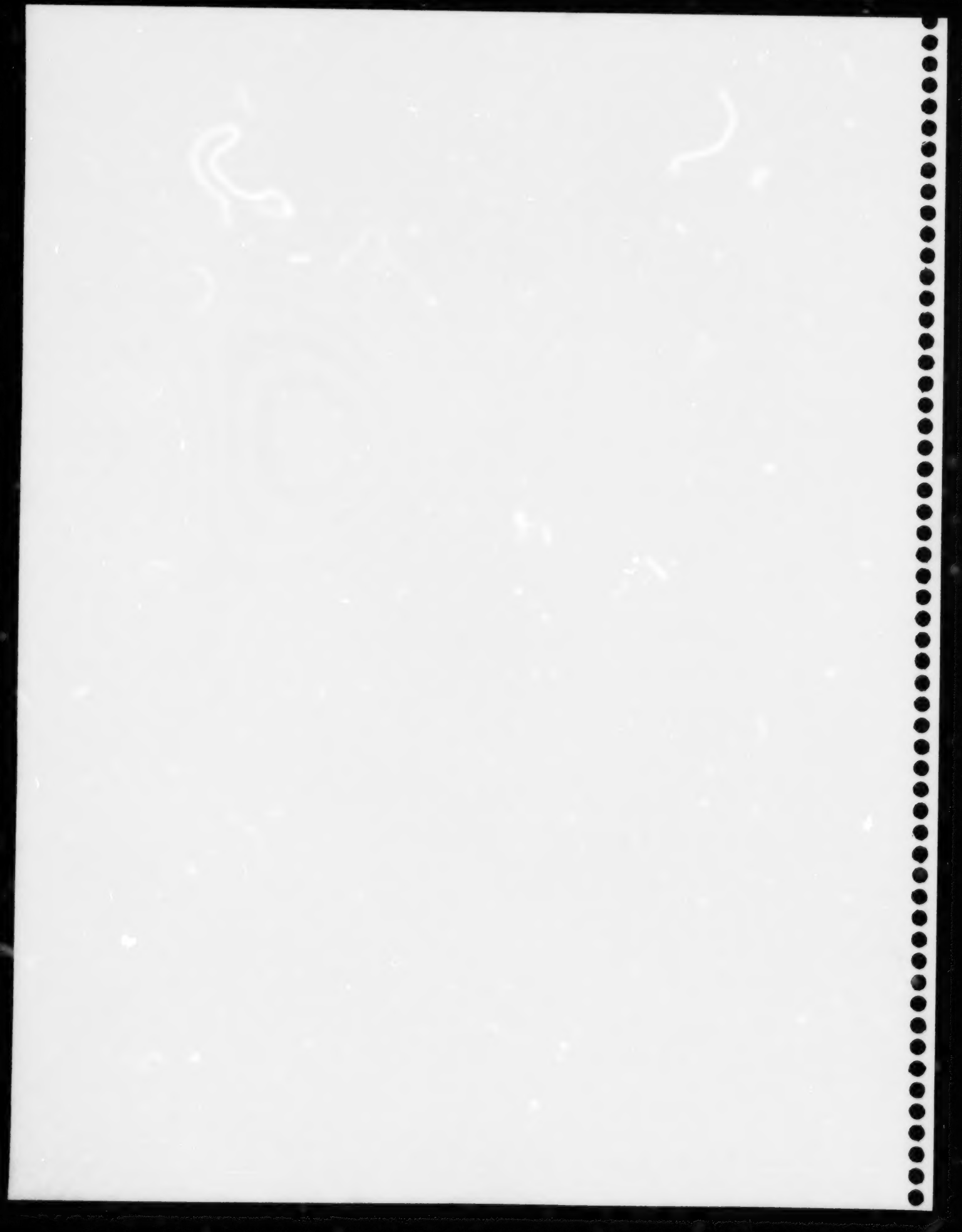
REFERENCES

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Transport Canada, Transport Dangerous Goods Directorate, S.F. 1205 P.C. incidents (General File), Volume 5 (Starts January 1988 to December 1988).

Province of Manitoba, 1988 Environmental Management.

Manitoba Hazardous Waste Management Corporation, Hazardous Waste Market Characterization Study for Manitoba, November 1989.

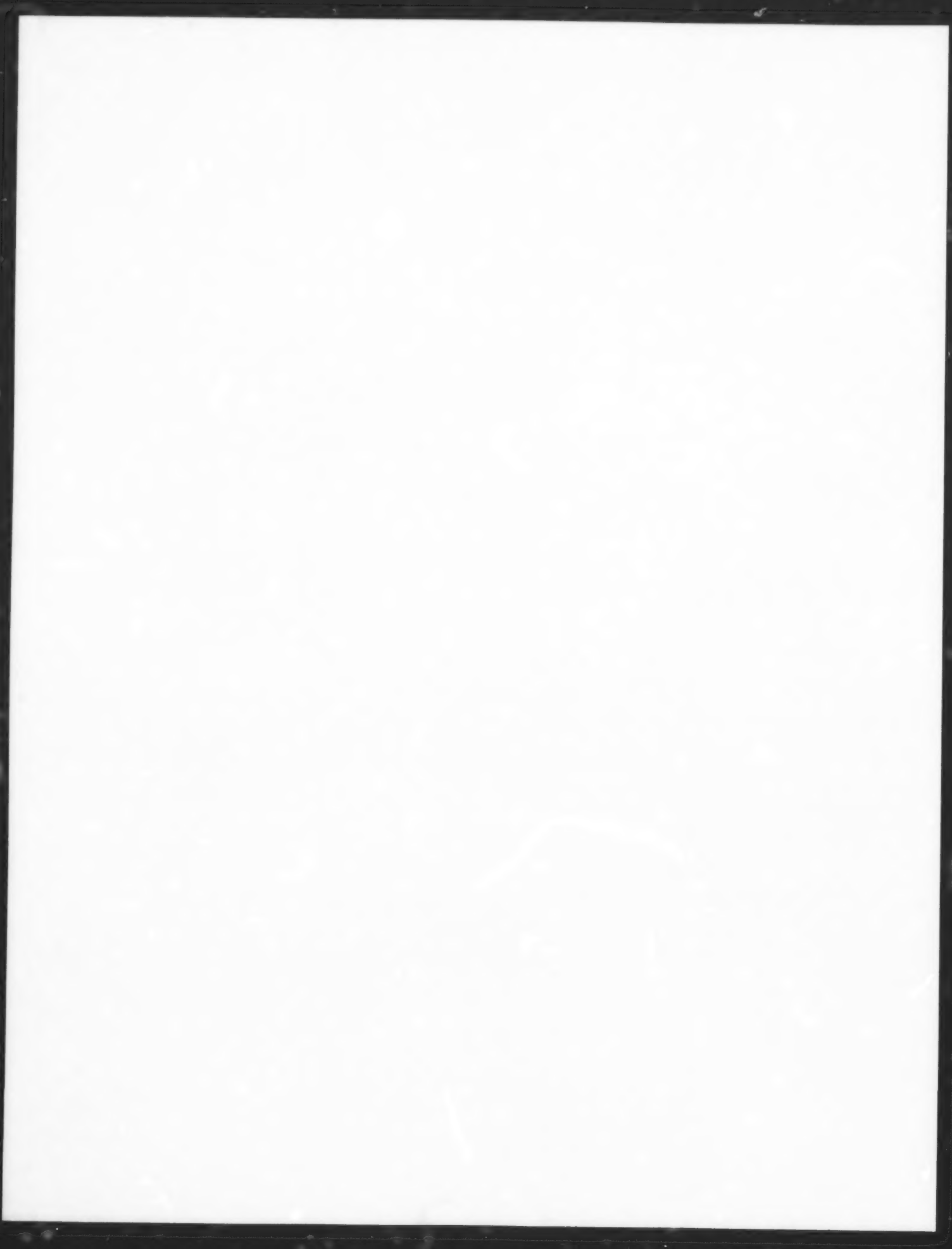


GLOSSARY

commercial traffic	- heavy vehicles (more than four wheels) involved primarily in the transport of goods, or in the delivery of a service (other than public transportation)
CUCD	- classification of hazardous wastes by the Consolidated University of California Davies system
dangerous commodity truck	- a commercial vehicle that is transporting a dangerous goods or hazardous waste
dangerous goods	- a product that is potentially harmful to the environment and/or public health and safety. It is classified as compressed gas, flammable or combustible, oxidizing, poisonous or infectious corrosive, dangerously reactive, explosive, or radioactive
EMO	- Emergency Measures Organization
ERP	- Emergency Response Plan
general accident frequency	- the standard measure of accident rate measured as: $\frac{\text{accidents}}{\text{vehicle-million km}} * \frac{(\text{number of accidents in link})}{(\text{number of vehicles on link per year}) (\text{length of link})}$
hazardous waste	- a waste material that is potentially harmful to the environment and/or public health and safety and fits the criteria of the CUCD system
hazardous waste production network	- regions consisting of groups of hazardous waste contributing communities, tied into the transportation network
links	- road/rail connections between nodes in the transportation network
MHWMC	- Manitoba Hazardous Waste Management Corporation
MOTORS	- an integrated package of computer programs used for data analysis and transportation modelling (see appendix)

node	- destination	- destination points in the transportation/production network
	- network	- end points of control sections/subdivision lines in the P.T.H./rail systems
	- production	- centroids of the generator regions in the production network
P.T.H.		- Provincial Trunk Highway
		- the highest level of highway in the Province of Manitoba
spill frequency		- the ratio of accidents where a spill has occurred to the total number of accidents involving commercial vehicles
total traffic		- all traffic, including passenger vehicles, trucks, vans, etc. for the road system; and all cars, tankers, etc. in the rail system
truck accident frequency to general accident frequency		- ratio of accidents involving trucks to the general accident frequency

appendices



APPENDIX 1
PRODUCTION NODES AND CONTRIBUTING COMMUNITIES

NODE	REGION	REGIONAL CONTRIBUTION IN KG	CONTRIBUTING COMMUNITIES		
1	WINNIPEG	19,067,203	WINNIPEG OAK BLUFF STONY MOUNTAIN STARBUCK ST. NORBERT LA SALLE GROSSE ISLE ST. FRANCOIS XAVIER	OAKPOINT ELIE FORT WHYTE ST. GERMAIN TYNDALL SANFORD SPRINGSTEIN	HEADINGLY VERMETTE DUGALD ANOLA ST. EUSTACHE STE. AGATHE OAKBANK
2	SELKIRK	1,323,255	SELKIRK EAST SELKIRK	LOCKPORT PETERSFIELD	GARSON QUARRY
3	BRANDON	408,076	BRANDON	GRISWOLD	
4	THOMPSON	250,181	THOMPSON NORWAY HOUSE WABOWDEN	LYNN LAKE GILLAM	LEAF RAPIDS NELSON HOUSE
5	WINKLER	201,234	WINKLER		
6	FLIN FLON	196,072	FLIN FLON	CRANBERRY PORTAGE	
7	PTG-LA-PRA	150,822	MACGREGOR BAGOT	AMARANTH OAKVILLE	PORTAGE LA PRAIR NEWTON SIDING
8	SNOW LAKE	88,933	SNOW LAKE		
9	STEINBACH	85,534	STEINBACH	KLEEFELD	BLUMENORT
10	DAUPHIN	75,848	DAUPHIN EDDYSTONE WINNIPEGOSIS	LAURIER OCHRE RIVER ETHELBERT	MCCREARY STE. ROSE DU LAC RORKETON
11	MORDEN	64,093	MORDEN		
12	ROSENORT	55,864	ROSENORT AUBIGNY	MORRIS ST. JEAN BAPTISTE	LOWE FARM

APPENDIX 1
PRODUCTION NODES AND CONTRIBUTING COMMUNITIES

NODE	REGION	REGIONAL CONTRIBUTION IN KG	CONTRIBUTING COMMUNITIES		
13	PINE FALLS	47,573	PINE FALLS BISSETT	GRAND MARAIS	TRAVERSE BAY
14	THE PAS	47,300	THE PAS		
15	NEEPAWA	41,742	NEEPAWA GLENELLA	GLADSTONE PLUMAS	EDEN
16	VIRDEN	38,905	VIRDEN MINIOTA	ELKHORN RESTON	OAK LAKE SINCLAIR
17	ALTONA	38,729	ALTONA HORNDEN	GRENA	ROSENFELD
18	SWAN RIVER	38,268	SWAN RIVER BENITO BOWSMAN	MINITONAS COWAN	KENVILLE BIRCH RIVER
19	SP-JOLYS	33,964	DUFROST ST. MALO	TOUROND ST. PIERRE-JOLYS	GRUNTHAL
20	BEASEJOUR	27,454	BEASEJOUR WHITEMOUTH	JANOW	RENNIE
21	GIMLI	24,506	GIMLI	MATLOCK	WINNIPEG BEACH
22	LAC DU BONNET	24,152	LAC DU BONNET	PINAWA	POINT DU BOIS
23	CARMAN	23,498	CARMAN BRUNKILD	MIAMI	ROLAND
24	SA-CHENES	19,570	ILE DES CHENES	LORETTE	LANDMARK
25	ROBLIN	19,006	ROBLIN GILBERT PLAINS	GRANDVIEW	INGLIS
26	NIVERVILLE	18,201	NIVERVILLE	ST. ADOLPHE	NEW BOTHWELL

APPENDIX 1
PRODUCTION NODES AND CONTRIBUTING COMMUNITIES

NODE	REGION	REGIONAL CONTRIBUTION IN KG	CONTRIBUTING COMMUNITIES		
27	TREHERNE	16,979	TREHERNE HOLLAND	NOTRE DAME DE LOURDES	
28	KILLARNEY	15,795	KILLARNEY MATHER	DUNREA	CARTWRIGHT
29	TEULON	14,765	TEULON	MALONTON	KOMARNO
30	CARBERRY	14,304	CARBERRY WELLWOOD	AUSTIN	SIDNEY
31	MANITOU	14,214	MANITOU SOMERSET	ALTAMONT	DARLINGFORD
32	ST CLAUDE	13,507	ST. CLAUDE HAYWOOD	RATHWELL FANNYSTELLE	ELM CREEK
33	ROSSBURN	13,402	ROSSBURN ANGUSVILLE	SHOAL LAKE SANDY LAKE	RUSSELL ELPHINSTONE
34	MINNEDOSA	13,135	MINNEDOSA NEWDALE	ERICKSON BETHANY	CARDALE CLANWILLIAM
35	ARBORG	12,298	ARBORG ARNES	FISHER BRANCH RIVERTON	HODGSON
36	RICHER	12,276	RICHER	HADASHVILLE	
37	ST LAZARE	11,846	ST. LAZARE BINS-CARTH	BIRTLE	FOXWARREN
38	STONEWALL	11,131	STONEWALL	WARRENTON	BALMORAL
39	SOURIS	10,793	SOURIS	CARROLL	HARTNEY
40	BOISSEVAIN	10,529	BOISSEVAIN	FAIRFAX	MINTO

APPENDIX 1
PRODUCTION NODES AND CONTRIBUTING COMMUNITIES

NODE	REGION	REGIONAL CONTRIBUTION IN KG	CONTRIBUTING COMMUNITIES		
41	ASHERN	9,824	ASHERN HILBRE	MOOSEHORN VOGAR	GYP SUMVILLE
42	GRAND RAPIDS	8,808	GRAND RAPIDS	EASTERVILLE	
43	DOMINION CITY	8,516	DOMINION CITY	EMERSON	LETELLIER
44	RIVERS	8,149	RIVERS		
45	ERIKSDALE	8,100	ERIKSDALE	LUNDAR	ST. LAURENT
46	MELITA	7,475	MELITA	WASKADA	DELORAINÉ
47	GLENBORO	7,444	GLENBORO WAWANESA	BALDUR	CYPRESS RIVER
48	CRYSTAL CITY	5,551	CRYSTAL CITY	LA RIVIERE	PILOT MOUND
49	SPRAGUE	5,192	SPRAGUE PINEY	ZHODA MIDDLEBRO	VITA
50	HAMIOTA	3,618	HAMIOTA		
	TOTAL	22,667,634			



MANITOBA HAZARDOUS WASTE
MANAGEMENT CORPORATION

PART 1
DATA COLLECTION
AND MODEL DEVELOPMENT
ROAD AND RAIL NETWORK
PRODUCTION NODES

DRAWING NO. TRA-1

MANITOBA HAZARDOUS WASTE MANAGEMENT CORPORATION

PART 1 DATA COLLECTION AND MODEL DEVELOPMENT

ROAD TRAFFIC VOLUMES (1987)

DRAWING NO. TRA-2

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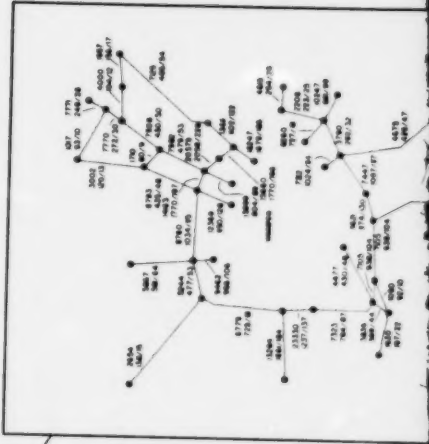
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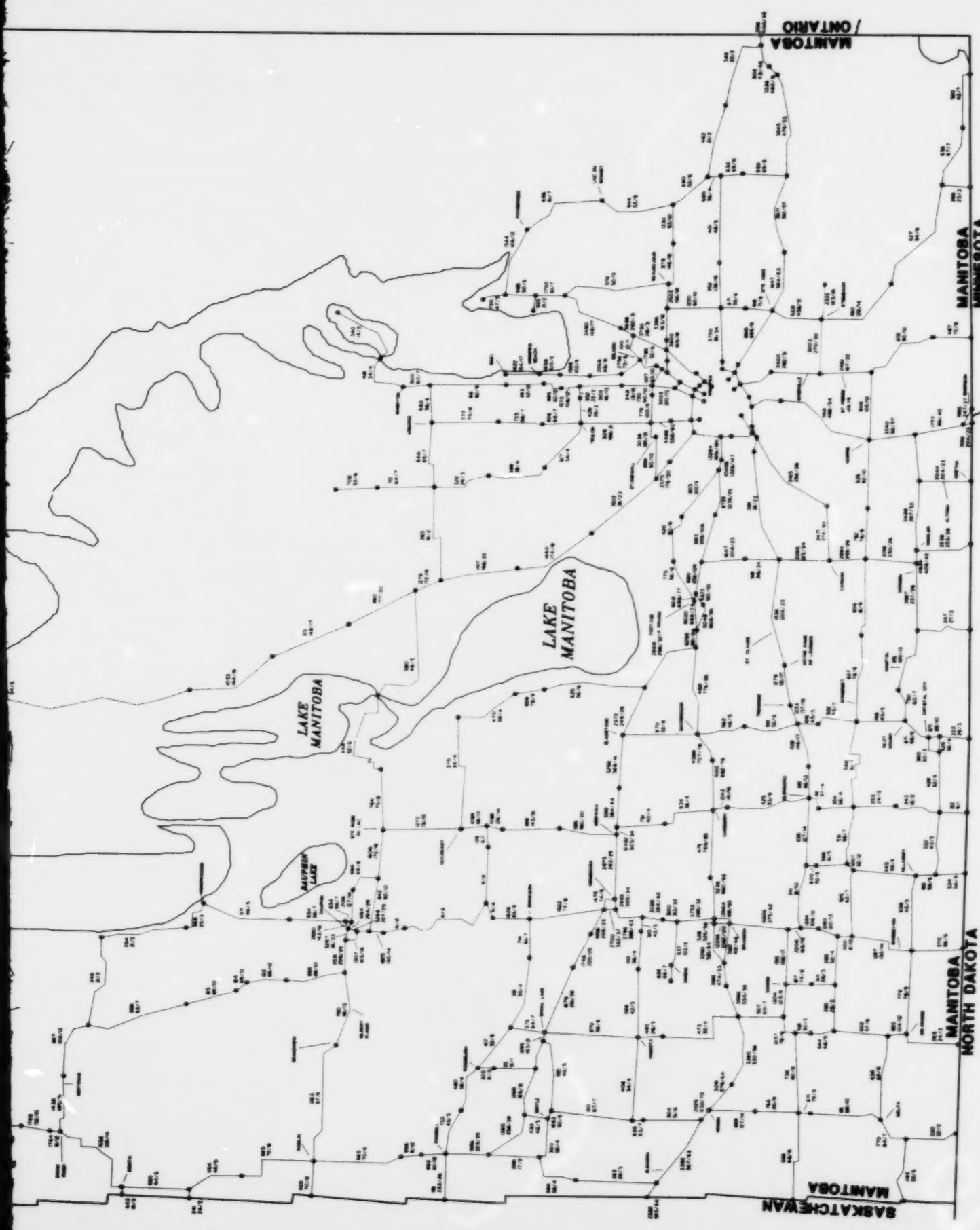
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CEDAR
LAKE

LAKE
WINNIPEGOSIS

LAKE
WINNIPEG





11,200,000
SCALE
LEGEND
DAILY TRAFFIC
1000
DAILY COMMERCIAL TRUCKS / DAILY DANGEROUS COMMODITY TRUCKS (ESTIMATED)

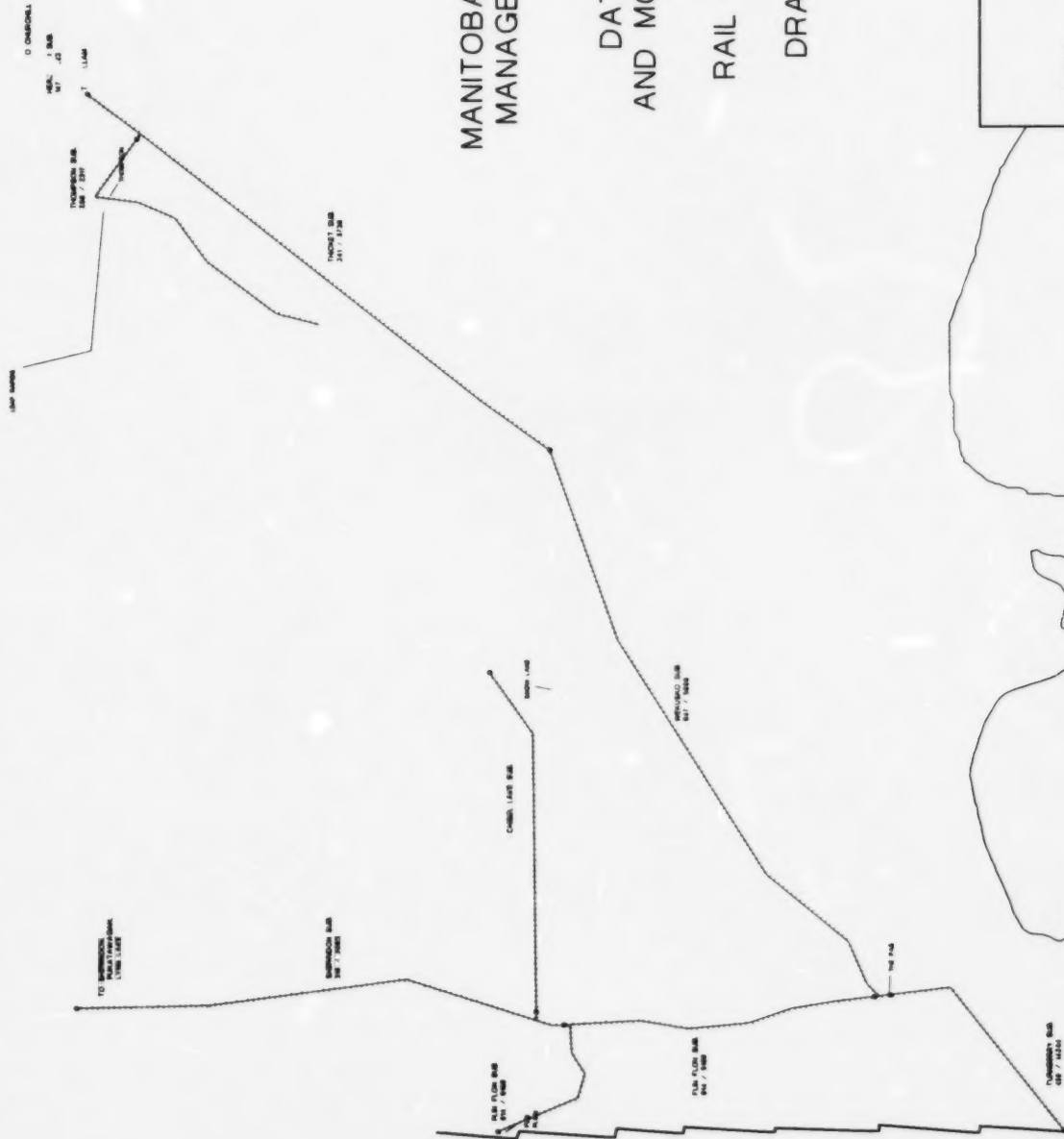
A map showing the survey route around Cedar Lake and Lake Winnipegosis. The route is marked with station numbers: 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200. The route starts at station 100 near Cedar Lake and ends at station 200 near Lake Winnipegosis. A north arrow is located in the upper right corner of the map.



1:50,000 ACCIDENT RATE INCIDENTS PER MILE (1960-1969)

SCALE 1:250,000

LEGEND

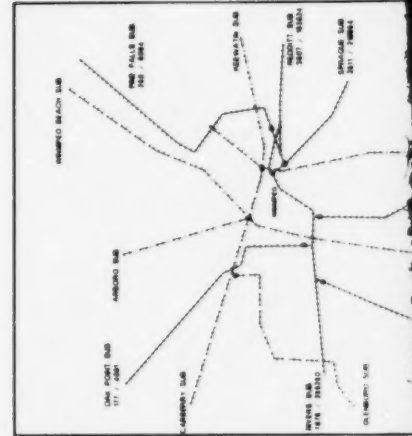


MANITOBA HAZARDOUS WASTE
MANAGEMENT CORPORATION

PART 1
DATA COLLECTION
AND MODEL DEVELOPMENT

RAIL TRAFFIC VOLUMES

DRAWING NO. TRA-4



CEDAR
LAKE

LAKE
WINNIPEG

LAKE
WINNIPEG





MANITOBA HAZARDOUS WASTE
MANAGEMENT CORPORATION

PART 1
DATA COLLECTION
AND MODEL DEVELOPMENT

1988 RAIL ACCIDENT DATA

DRAWING NO. TRA-5



